The Effects of Tea Polyphenolic Compounds on Hair Loss among Rodents

Adeleh Esfandiari, DVM, PhD and Paul Kelley, MD
Los Angeles, California

The objective of this study was to examine the effects of polyphenolic compounds, present in noncommercially available green tea, on hair loss among rodents. In an experimental study, we randomly assigned 60 female Balb/black mice, which had developed spontaneous hair loss on the head, neck and dorsal areas into two equal groups; A (experimental) and B (control). Group A received 50% fraction of polyphenol extract from dehydrated green tea in their drinking water for six months. Group B received regular drinking water. Both groups were fed regular rodent diets (Purina Rodent Chow 5001) and housed individually in polycarbonate cages. The results showed that 33% of the mice in experimental Group A, who received polyphenol extract in their drinking water, had significant hair regrowth during six months of treatment (p=0.014). No hair growth was observed among mice in the control group, which received regular water.

Key words: hair loss ■ alopecia ■ green tea ■ polyphenolic compounds

 From Department of Otolaryngology (Esfandiari, professor; director of biological research), Charles R. Drew University of Medicine and Science (Tran) and the Division of Dermatology, King Drew Medical Center (Kelley, professor of internal medicine, chief). Send correspondence and reprint requests for *J Natl Med Assoc.* 2005;97:816–818 to: Adeleh Esfandiari, DVM, PhD, International Health and Tropical Medicine, 1731 E. 120th St., Los Angeles, CA 90059; phone: (323) 563-5986; fax: (323) 563-5940; e-mail: adesfand@cdrewu.edu

INTRODUCTION

Hair loss is a common and distressing problem among human and other mammals. Hair loss in rodents is reported to occur spontaneously resembling human alopecia[6,13] or due to overgrooming behavior,[8,9,15] androgens[19-21] or skin inflammation associated with hair loss and insufficient husbandry.[5,18] Overgrooming or barbering in rodents occurs as a result of overcrowding.[7,18] However, if the mice are separated into individually occupied cages, their hair will regrow. There are several reports using different regimens for treatment of hair loss. Freischmit and colleagues[1,6] reported successful treatment of alopecia-like hair loss with contact sensitizes squaric acid dibutylester among mice.

There are several reports about the anti-inflammatory and skin cancer preventive effects of polyphenolic compound found in green tea.[4,10,17] In several studies using mice, the anti-inflammatory and skin cancer preventative effects of green tea were found to be due to its polyphenolic constituents. These components have been shown to modulate biochemical pathways important in inflammatory responses, cell proliferation and responses of tumor promoters. Several parameters, such as NK cell activity, antibody-dependent cellular cytotoxicity, induction of specific antibody and T- and B-cell proliferation, have been used to evaluate the immuno-stimulating activity of polyphenols and green tea.[4]

The polyphenolic compositions in green tea are related to flavanols, commonly known as catechins. It has been reported that flavonoids significantly enhanced lymphocyte proliferation and caused a significant recovery of IL2 production and an increase in lymphocyte proliferation and NK cell activity in mice.[5]

Katiyar and colleagues[11] reported that the oral consumption of polyphenolic fraction isolated from green tea in mouse models affords protection against inflammation, chemical carcinogens and photocarcinogenesis.[4] For example, oral feeding of green tea to Balb/c (color code for albino) mice resulted in significant protection against skin tumors.[17,23] There are also reports on the protective effect of green tea against erythema, edema and hyperplasic epithelial responses

of skin in mice.[10,12]

Although there are abundant reports demonstrating the evidence regarding the anticarcinogenic properties of tea polyphenols, there are no reports of their effectiveness on hair loss. In this study, we decided to examine the effectiveness of tea polyphenols on hair loss in mice.

MATERIALS AND METHODS

Animals

Female Balb/black mice were purchased from Harlan Sprague Dawley Laboratories for a drug trial experiment. After the project was completed, the mice that served as controls were kept in our facility for student training projects. These mice were free of any infections. Among these mice, 60 were noticed to have developed spontaneous hair loss at the age of six months. These mice were individually housed, fed Purina Chow 5001 diet and kept on a 12-hour light/12-hour dark cycle. In order to rule out the possibility that hair regrowth was due to spontaneous remission, we selected mice with identical hair loss and randomly assigned them into two groups. Group A received polyphenol extracts of green tea in their drinking water, while group B received only regular drinking water. To control for possible drinking differences, mice from both groups were monthly noted for changes in weight.

Preparation of the Polyphenol Fractions from the Green Tea

Noncommercially available, dry green tea leaves (100 g) were extracted with 300 ml of 50% methanol at 50° C for three hours. The solution was filtered and the solvent removed under a vacuum rotary evaporator. After final extractions, the dried extract weighed 10.5 g and was dissolved in 500 ml sterile water.

Measurement of Hair Loss and Regrowth

The extent of hair loss was measured by marking the area of bare skin with permanent ink (mm^2) using a transparent grid. The hair regrowth was quantified by computing the difference in bare skin areas before (marked area) and after treatment.

STATISTICAL ANALYSIS

Slope of linear regression was calculated between time and rate of hair growth in treatment and control groups, respectively, and the Student's t test was used for significant changes of hair growth on the surface of the skin among groups under trial. Statistical significance was considered at $p<0.05$.

RESULTS

Thirty-three percent of the mice who received green tea extract in their drinking water developed hair regrowth within a period of six months with an average surface regrowth rate of 1.6 mm^2 per month (Table 1 and Figures 2a, 2b). Statistical analysis showed that group A had a significant increase in hair growth compared to group B, who received no green tea extract in their drinking water ($p=0.014$).

Histopathological analysis of the treated group showed progressive follicular growth. (Figures 3a, 3b, 4a, 4b). We did not observe any spontaneous remission or hair regrowth among the controls. Moreover, 8% of the control rodents showed progressive hair loss during our study, whereas none of the mice who received polyphenoline extract derived from the tea showed any progressive hair loss. The control rodents developed secondary infections resultant of their extensive, progressive hair loss. During the six months, there were no significant differences in weight gain or loss in either study group.

DISCUSSION

The etiology of hair loss is not well understood. Hair growth is cyclic, with phases of growth (anagen), involution (catagen) and rest (telogen).[14] The cycles of active growth and rest are regulated by complex messages between the epithelium and the dermis that are not yet well understood.[16] Hair follicles can become larger or smaller under systemic and local influences that alter the duration of anagen and the volume of the hair matrix.[14,16]

Table 1. Mean + SE Hair Growth Changes on the Surface Area of Skin following Treatment with Green Tea in Mice

Group	Hair Loss (mm^2)	Hair Regrowth (mm^2)	
		Difference in Six Months	Difference in 12 months
Green Tea (n= 30)	1.61 ± 0.096	0.53 ± 0.062	0.79 ± 0.093
Control (n=30)	1.58 ± 0.074	-0.09 ± 0.025	-0.16 ± 0.036
Statistical Significance	NS	$p<0.05$	$p<0.05$

SE = standard error; n = number of mice; NS = not significant

A wide range of peptides, transmitters and hormones, such as corticotrophin-releasing hormone, substance P (SP), ACTH, b-endorphin, prolactin, progesterone and catecholamine, mediate and modulate systemic stress responses. Animals individually housed have been shown to undergo a stress response due to their isolation.[3] It has been shown that these stress factors can alter hair growth in mice.[2]

It is reported that mice with symptoms of alopecia areata, when treated with squaric acid dibutylester, showed overt hair regrowth. Histopathological examination of these animals revealed a change in the distribution of the inflammatory infiltrate of perifollicular lymphocytes around the mid and lower region of hair follicles.[6,13,22]

In our study, we observed spontaneous hair loss on the ventral and dorsal areas of 60% of the disease-free Balb/black female mice at the age of six months. Group A received polyphenoline extract from green tea in their drinking water and group B received regular water to serve as controls. Both groups were kept in identical environmental conditions (i.e., housed individually and were fed the same diet). There were no significant differences in weight gain or loss in either group. We observed hair regrowth among 33% of the mice that received green tea extract and did not observe any spontaneous remission or hair regrowth among the controls. Eight percent of these controls of showed progressive hair loss during the period of our study, whereas none of the mice who received polyphenoline extract showed any progressive hair loss.

There is abundant evidence that polyphenolic substances are considered as anti-inflammatory and have stress inhibitory characteristics, and there is evidence that stress inhibits hair growth. However, there are no previous reports of the effects of tea polyphenols on hair loss. We feel that the findings of this study are unique and, due to limited reports on tea polyphenols and hair loss, the referencing in this study was limited to older texts and manuscripts. In this study, we attempted to measure the effects of polyphenoline on hair loss rather than identify the etiology of hair loss.

We conclude that anti-inflammatory and stress inhibitory effects of these natural substances may influence hair regrowth among mice. Further studies are in progress to explore the mechanisms and factors involved in hair regrowth in association with the polyphenols in green tea.

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